Environmental fat tails: what have ecosystems ever done for us? **By Vera Van Gool**

Doomsday scenarios of freak weather events, mass climate migration and out of hand forest fires are just part of the vivid imagery that come to mind when thinking about climate change (CC). CC has well and truly been put on the global political agenda and public awareness of the issue has grown immensely over the last decades. Since studying CC is part of researching the functioning of the complex Earth System, CC is a complex research topic. Determining the causes, future trends and gravity of the consequences of CC are just some among the many controversies in researching it. Many of the risks CC will impose on humanity and nature can be classed as *fat-tails*; a great majority of its currently discussed risks are known for their gravity, but also their unexpectedly growing probabilities.

The imagery just referred to describe risks that are discussed elaborately in the climate debates. However, I would like to call your attention to another problem I will class as a CC fat-tail risk, namely: loss of ecosystem resilience (henceforth LoER). The imagery this should bring to mind forms a parallel with the examples above; sea storms destroying vulnerable, bleached coral reefs, mass migration of species and prolonged drought that result in fires destroying forests. A genuine question therefore, would be: why is it we do not discuss LoER as much? Let me pick up on that worry and elaborate on it here, as this risk is worth our attention for reasons I hope to demonstrate.

As a means of dealing with the uncertainty implicit in fat-tails, economic tools are often called upon to partly determine the right course of political action. Cost-benefit analysis (CBA) is one of the measures most widely used in policymaking and for problems relating to ecosystems specifically the framework of 'ecosystem services' is often enlisted.[1] These tools implicitly assume that humans can accurately know and put a value on the functions of ecosystems that are beneficial to humankind and can be regulated economically. The difficulties when using this 'standard' model in dealing with LoER are that predictions and future scenarios are highly uncertain and in some cases probabilities or monetary values cannot be assigned to do any potential weighing of the costs and benefits with. Moreover the risk of completely unforeseen events[2] coming to pass is impossible to predict, but still likely as CC's impact on ecosystems reach far into the future and our scientific models cannot capture these prospects.

A precautionary approach with help of the precautionary principle (PP) is sometimes proposed as an alternative to CBA.[3] It is this alternative reasoning that I want to endorse in this paper whilst aiming to answer the following question:

~ How should we address the issue of LoER in the context of climate change governance?

In this paper I argue that a solely economic approach[4] to CC risks is inadequate for tackling this major, 'fat tail' issue of LoER and the amplification of CC as a possible feedback resulting from this. A high degree of uncertainty in this field of research seems to pull us in the direction of following the PP instead. However, interpreting the PP is in no way a straightforward matter. I argue that integrating the PP with evolutionary biology and (virtue-)ethics, with a particular emphasis on the

[1] See e.g. United Nations Environment Program website on 'ecosystem management' http://web.unep.org/ecosystems/what-we-do/economics-ecosystems last accessed 07-09-2016.
[2] A form of so-called 'black swans' and 'unknown-unknowns' in particular see e.g. T. Aven, and O. Renn, "An Evaluation of the Treatment of Risk and Uncertainties in the IPCC Reports on Climate Change", *Risk Analysis,* Vol. 35, No. 4, 2015: pp.708-709.
[3] Daniel Steel, *Philosophy and the Precautionary Principle: Science, Evidence, and Environmental Policy.* (Cambridge: Cambridge University Press, 2015): 21.
[4] The analysis of what I call 'the economic approach' will be limited to CBA in conjunction with the framework of ecosystem services.

virtues *humility* and *courage*, potentially is a more helpful approach in determining how we should value nature and protect (future) human well-being.

1. The fat-tail problem

First we have to establish what we are actually concerned with in this paper. We are concerned with the issue of LoER due to CC and the adverse feedbacks this might feed back to the climate system. A few questions come to mind that need to be answered in this part of the paper: what is LoER? What is CC's impact on ecosystem resilience? What sort of adverse feedbacks to CC could LoER have? And, how is this a fat-tail issue?

I will start by explaining in short what I mean when I refer to ecosystem resilience. Let me start by describing that ecosystems are:

> Natural systems in which living and non-living parts of the environment interact with each other to form functional cycles of matter and energy and structures of interaction.[5,6]

Resilience then is the ability of an ecosystem to recover from disturbances, maintaining a relative stability[7] and loss of resilience is characterised by the increased difficulty a natural system experiences to recover from disturbances which happens, among other occasions, in the approach of a tipping-point[8].[9] Resilience can be categorised into two types: 1) specified and 2) general resilience.[10] Specified resilience is resilience *in relation to* something, in other words: how a specific type of flexibility of a system, e.g. grass compositions, is beneficial to another phenomenon, namely sustainable grazing of livestock. Whereas general resilience refers to the flexibility in a system that could respond to a broader, unspecified, often unforeseen and novel set of disturbances. We now realise for example that natural forest fires actually improve forest resilience instead of decreasing it. In more philosophical terms I would like to class specified resilience as being of *instrumental* value and general resilience of *potential*[11] value.[12]

The distinction between instrumental and potential value is particularly relevant here, since the question can be asked: should we only care about resilience insofar as it prevents a disastrous tipping-point from occurring? I would like to argue that this is *not* the only reason we should consider

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[5] Eugene P. Odum, "Ecosystem, Concept of," *Encyclopedia of Biodiversity* 2 (2001): 305.

[6] From this definition it does not become clear what size ecosystems characteristically are as their boundaries can be 'natural or arbitrary'. The scale of ecosystems I'm interested in here would be a region with its distinct species that is separated from other ecosystems by (natural) geographical features such as a mountain range, river, but also a border of other vegetation (e.g. where a tropical rainforest borders a savanna). They are small enough to be of particular significance to local populations, be it of human or non-human organisms, but big enough to suffer significant impacts by CC.

[7] The problem with the concept 'resilience', is that it is an elusive and dynamic concept and accommodates a great deal of change when humanity might not want to accept certain kinds of changes. Resilience can mean 'bouncing *back* from a disturbance' or 'finding a *new state* of stability after a disturbance'. Bouncing back would imply that a system returns to its former state after coping with a disturbance, whereas finding a new state of stability implies that a system changes its make-up, and sometimes output, dramatically. The impact of either type of resilience on societies is consequently very different; assuming that ecosystems have invaluable functions for the sustenance of societies, the continued rendering of these functions or a drastic change in functions will have consequences for the level of adaptation needed in governance.

[8] A tipping-point is characterised by a crucial point in a natural system after which a drastic change occurs altering the makeup of the whole system.

[9] Timothy Lenton, " Early warning of climate tipping points," *Nature Climate Change* (2011): 201 .& Lei Dai et al., "Generic Indicators for Loss of Resilience Before a Tipping Point Leading to Population Collapse," *Science* 336 (2012): 1175.

[10] Fiona Miller et al., "Resilience and Vulnerability: Complementary or Conflicting Concepts?" *Ecology and Society* vo 15, no 3, article 11 (2010): 3.

[11] This is an epistemic rather than a ontological distinction. That is to say that 'potential' value is not anything different from the concept of instrumental value, it is just to denote that we might be unaware of some phenomenon's instrumental value.

[12] The reason why I do not use the term *intrinsic* value I will explain in the second part of the paper.

resilience. The main reasons for this is that 1) not all disturbances in ecosystems lead up to a tipping-point, but can still cause a significant change we have to consider and adapt to, and 2) in many cases we cannot be sure disturbances lead to a prospected tipping-point, but it is arguably still safer to regard them as if they would cause significant disruption. Therefore resilience is not only of instrumental value, as a means to protect us from prospected harm, but also of potential value since it creates a form of insurance against possible disturbances we cannot foresee, but might still occur.

Research suggests that ecosystem stability is currently under threat from CC on top of direct human activities.[13] The main problem with CC is that it causes ecosystem locations to shift geographically due to changes in e.g. temperature and weather patterns. As a result of this many species are unable to cope with the changes and likely dieback or go extinct.[14] Changes that might be involved are alterations in the interaction between species, or in migration patterns of species.[15] To predict these changes is a challenging task. Scientists would have to predict the ranges of species (e.g. in which conditions they thrive and their migration abilities), predict the climate change patterns that are likely to occur for the specific locale and connect these insights.[16] Complex computer modelling might be up for the task however, in order to connect the two predictions many crucial assumptions and simplifications have to be made, making the endeavour uncertain.[17]

Without specifying a particular ecosystem to focus on, a list of impacts stays altogether quite abstract. Unfortunately I do not have the scope to elaborate on an example here.[18] The direct impacts include anything from a response of ecosystems to increased greenhouse gasses (GHGs), through a loss of habitat due to sea level rise or more frequent fires, to glacial recession.[19] Indirect impacts include anything from a change in the metabolism of organisms, through a decoupling of coevolved species' interactions, to shifts in species distributions and migrations.[20] In turn the impact of LoER and changes in ecosystems on CC include e.g. a reduced capacity to reflect sunlight in the case of glacial recession, amplifying CC. Or an increase in the storage CO^2 due enhanced vegetation growth, dampening CC. However, in some cases higher levels of CO^2 and its storage in, say the ocean, reach saturation levels meaning an increase of ecosystems releasing GHGs back into the atmosphere, amplifying CC.[21]

How is LoER a fat-tail issue? My understanding of a fat-tail risk is that it is a risk characterised by an increased probability when in 'normal' predictions it receives a low-probability. Essentially a fat-tail signifies a *shift* in the distribution of probabilities attributed to risks or events; a *change in a trend* resulting in a higher chance for events to occur which we normally would not expect to happen. One of the best examples that represents a fat-tail event in ecosystems due to the impact of CC can be found in circumstantial evidence that coral reefs in certain geographic regions undergo 'rapid' evolution to adapt to higher sea temperatures.[22] This is an unexpected outcome insofar as evolution is normally understood as a gradual and slow process, rapid evolutionary adaptations are therefore somewhat of a fat-tail chance and a positive one at that. However, even though there is preliminary evidence that coral and algae distribution changes may come down to evolutionary

[13] H. Mooney et al., "Biodiversity, climate change, and ecosystem services" *Current Opinion in Environmental Sustainability* 1 (2009): 46.
[14] S.L. Pimm, "Biodiversity: Climate Change or Habitat Loss — Which Will Kill More Species?" *Current Biology* Vol 18, No 3 (2007): R117.
[15] H. Mooney et al., "Biodiversity, climate change, and ecosystem services" *Current Opinion in Environmental Sustainability* 1 (2009): 46 & 49.
[16] S.L. Pimm, "Biodiversity: Climate Change or Habitat Loss — Which Will Kill More Species?" *Current Biology* Vol 18, No 3 (2007): R117.
[17] Ibid.: R117-8
[18] For examples see e.g. Jonathan Mawdsley, "Design of conservation strategies for climate adaptation" *WIREs Climate Change* Vol 2, July/August (2011): 498-515.
[19] Ibid.: 498.
[20] Ibid.
[21] H. Mooney et al., "Biodiversity, climate change, and ecosystem services" *Current Opinion in Environmental Sustainability* 1 (2009): 50.
[22] T.P. Hughes et al., "Climate Change, Human Impacts, and the Resilience of Coral Reefs " *Science* 301, 929 (2008): 930.

changes, scientists warn that the rate of environmental change will probably still far outweigh the adaptive capacity of coral reefs.[23] Partly because of the longevity of corals and their evolutionary state they have evolved to reach over multiple decades.[24]

The crux in governing any risk is the perception policymakers and the public have of it. Attention usually goes out to risks generally perceived to be very grave, the ones that are likely to happen and the ones that will be the most costly, both monetarily and more broadly speaking in terms of loss or effort to prevent or adapt to.[25] With this weight being given to 'costly' side of the spectrum of risks, many other, arguably significant, risks that are less well understood will be overshadowed. LoER often proves to be such a risk; public awareness of ecosystem degradation and the gravity of its possible consequences[26] is limited and the issue often does not make it onto the political agenda. Lack of awareness is the first obstacle in creating a proper concern for LoER, plus humans have difficulty assessing the interrelatedness of issues that play up in ecosystems because of their complexity. In addition to the difficulty in foreseeing and evaluating novel risks like the ones occurring in ecosystems due to CC, and the timescale at which these issues play out is often not represented in the assessments.[27] Another obstacle to this is however, that it is hard to make this risk tangible and intelligible to policymakers and the wider public for reasons of the inadequacy of the methods used to assess risks, namely the economic approach that is often taken. I will elaborate on the inadequacy of this approach in the second part of this paper.

Concluding LoER due to CC is characterised by the inability of ecosystems to recover from disturbances, creating instability. It is a risk with an unexpectedly growing probability with widely varying consequences affecting CC and is accompanied by high scientific uncertainty. It often fails to make the political agenda with the same urgency as other CC issues do as (public) awareness and (scientific) understanding are lacking. However, LoER's impacts can be classed as significant both for nature and society as the second part of this paper will demonstrate in more detail.

2. A critique of the economic approach and some alternatives

To be able to put forward the main argument of this paper[28] we need to look into what the economic approach entails, which alternatives are proposed and how they can be analysed critically. The analysis of what I call 'the economic approach' will be limited to CBA in conjunction with the framework of ecosystem services. I will also go into another form of value ascription that is often proposed in philosophy as an alternative which I believe has limited merits, namely that of *intrinsic* value.

Ecosystem cycles have in- and outputs of which humanity benefits in major economic and societal ways. For example the ecosystem in which bees pollinate flowering plants helps to maintain both the bee colonies and plants, but this pollination is also essential for agriculture. These types of services provided by ecosystems, like the pollination service, are often called 'ecosystem services'.[29] The preservation of these services can thus be argued for from the socio-economic perspective. However, these ecosystems and their services have evolved for over billions of years of evolution and

[23] T.P. Hughes et al., "Climate Change, Human Impacts, and the Resilience of Coral Reefs " *Science* 301, 929 (2008): 930.
[24] Ibid.
[25] Gretchen Daily et al., *Nature's Services, Societal Dependence on Natural Ecosystems* (Washington D.C.: Island Press, 1997): 38.
[26] Perhaps with the exception of the knowledge of locals directly dependent on an ecosystem.
[27] Ibid.: 38-43.
[28] That the PP in combination with evolutionary biology and virtue-ethics is a more successful alternative to economic approaches in governing the fat-tail risk of LoER
[29] Gretchen Daily and Shamik Dasgupta, "Ecosystem Services, Concept of," *Encyclopedia of Biodiversity* 2 (2001): 353.

work in very intricate and poorly understood ways. The main driving forces behind them are thought to be natural chemical and energy cycles and biodiversity.[30] These in turn operate on different scales making the analyses of the functioning of ecosystems a complex affair. The recommendation of ecologists to have regard for this complexity[31] and the principle of 'diversity' is understandable, but not always popular in the scientific field where the principle of 'simplicity' rules. Researchers stress we cannot always evaluate ecosystems properly, especially in monetary terms that often dictate our policy-making standards. Scientific research might be able to fill this gap and provide us with the information to distinguish valuable from less valuable ecosystem services. This leaves us with the problem that until we know what is important we have, from an economic perspective at least, no reason to attribute value to any part of nature. Plus even if we do hold the knowledge of a service's importance, there is no guarantee we can assign a proper value that covers nature's true worth. Scientific uncertainty and ignorance is therefore a great limitation to this empirical and socio-economic approach.

The framework of ecosystem services is very much anthropocentric; humans are the determinants of what is valuable and what is valuable is determined by a phenomenon's utility to humankind.[32] Even though anthropocentrism is often frowned upon in environmental philosophy debates, there is nothing *essentially* wrong with this stance. After all, the cognitive ability of *valuing* we only know intimately from a human perspective. What seems indefensible would be to jump to the conclusion that the only morally relevant beings are humans, and this is the way anthropocentrism is characterised most often[33]. Moreover, there is something erroneous in concluding that the phenomena we *know* to value are the only things that are *valuable*, because humans are also notorious for making (value) misjudgements.

The basic aim of maximising benefits and minimising costs that underlies CBA resonates the utilitarian tradition in philosophy and particularly what we might call a 'strong' version of it; what is considered a 'good' or 'moral' action aims to satisfy the desires of the majority of society.[34] One of the problems that arises with aiming for majority satisfaction is obvious: what the majority values is not necessarily what should be valued as preferences might actually be detrimental to happiness and satisfaction in the long run.[35] In a persistent manner humans are inclined to think that something is only valuable if its utility to us is demonstrable, hence ecosystems are only valuable to us in so far as we can name the goods and services they provide. We might then be able to value it in a currency, e.g. money, to weigh how valuable it 'actually' is in CBAs.[36] This connection between what we know and what we value plays an important role in debates about ecosystems and their utility. We know that ecosystems provide us with goods and services, like timber and pollination, roughly speaking we know how as well, through natural cycles that allow for vegetation and non-plant species to live and thrive. The action of naming ecosystems utilities, and through this making explicit which parts of it

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[30] Gretchen Daily and Shamik Dasgupta, "Ecosystem Services, Concept of," *Encyclopedia of Biodiversity* 2 (2001): 356.
[31] Bartosz Bartkowski et al., "Capturing the complexity of biodiversity: A critical review of economic valuation studies of biological diversity," *Ecological Economics* 113 (2015): 8.
[32] Bryan Norton, "Anthropocentrism," *The International Encyclopedia of Ethics,* (2013): 309 & Gretchen Daily et al., *Nature's Services, Societal Dependence on Natural Ecosystems* (Washington D.C.: Island Press, 1997): 24.
[33] Bryan Norton, "Anthropocentrism," *The International Encyclopedia of Ethics,* (2013): 312 & Gretchen Daily et al., *Nature's Services, Societal Dependence on Natural Ecosystems* (Washington D.C.: Island Press, 1997): 26.
[34] Gretchen Daily et al., *Nature's Services, Societal Dependence on Natural Ecosystems* (Washington D.C.: Island Press, 1997): 26.
[35] A question that can be asked is: should preferences weigh equal amounts? Philosopher John Stuart Mill has contemplated this question in the 19th century and he concluded that there are distinctions to be made when it comes to the *quality* of our preferences; some desires are more justified and of a higher quality in terms of contributing to happiness that other desires are (John Stuart Mill, *Utilitarianism* London: Parker, Son, and Bourn, West Strand, 1863: 221). Quality distinctions get us in a very precarious area of philosophy however, because: who decides and with which argumentation what is qualitatively, but *objectively* better than another preference?
[36] Ibid.: 24.

are valuable, could partly explain why the ecosystem services narrative has been predominantly monetary in focus and combined with CBA.

However, we might be unaware of *potential* goods and services ecosystems provide. We can think of the alleged quality of nature to de-stress our minds and make us humbler by its awe-inspiring power. Another thought can be of the goods we might discover when we learn how to utilise nature's products, like we have learned to use the fibres of nettles for making fabric. Or potential knowledge we might gain, for example in biomimicry[37] a scientific field in which innovation is primarily inspired by nature's efficiency and sustainability. It becomes increasingly hard to put a value on these potential commodities and, as tragedy would have it: most of the benefits we reap from functioning ecosystems only become apparent to us through their degradation.[38] It is argued by, among others, Daily et al. that we need a comprehensive measure for ecosystems' value as the alternative would be to ignore them altogether too easily.[39] The question can be asked however, whether lack of this value-measure does necessarily lead to ignoring their worth and presenting this value-measure is indeed the only alternative.

In recognition of this difficulty of putting a value on the goods and services ecosystems potentially yield, the argument could follow that we should research ecosystems more. The two most dominant reasons for pursuing scientific research are: 1) for the sake of preserving the poorly understood services society depends on so much, or 2) in order to fathom how they work and in due time enable us to substitute them. If in the future we are able to substitute natural ecosystem services with technological fixes[40] there would be no reason from these perspectives to maintain natural ecosystem services. This begs the question whether by holding these views we would neglect other values of nature, like the potential unknown services I hinted at above.[41]

Alternatively there are other, predominantly non-anthropocentric ways of expressing the value of nature proposed in philosophy. Often these other methods of evaluation ascribe an intrinsic value to nature and are dubbed 'biocentric'; all living organisms have a (moral) worth independent of their relationship to other organisms.[42] By some it is described as the polar opposite of anthropocentrism as a theory that does not assume humans have a moral superiority, which they believe anthropocentrism entails.[43] To my mind this is a narrow conception of anthropocentrism, because it can also 'just' mean that human beings are the sole determinants of (moral) value.

The concept of intrinsic value is regularly attributed to a deontological or Kantian set of basic assumptions.[44] Kantian approaches are characterised by a moral obligation to respect the autonomy or integrity of phenomena which results in a duty to acknowledge intrinsic value in other beings.[45, 46]

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[37] The science of imitating biological functions for sustainably solving human problems, for more see: http://biomimicry.org/ accessed 17-06-2015.

[38] Gretchen Daily et al., *Nature's Services, Societal Dependence on Natural Ecosystems* (Washington D.C.: Island Press, 1997): 5.

[39] Ibid.: 8.

[40] There are many objections to be found against the proposal of tech-fixes. See e.g. Hubris objection and the concern of moral hazard, Benjamin Hale "The world that would have been: Moral hazard arguments against geoengineering." *Reflecting sunlight: The ethics of solar radiation management. Rowman and Littlefield, Lanham* (2012).

[41] Additionally it makes us wonder if the (in-)ability to substitute for ecosystem services prescribes us to pursue this goal or not and whether research of ecosystems and their services presupposes that we value nature in another way. Unfortunately I have not got the scope within this paper to address these two questions, so I will leave them here for others to ponder.

[42] Robin Attfield, "Biocentrism," *The International Encyclopedia of Ethics* (2013): 526 & Gretchen Daily et al., *Nature's Services, Societal Dependence on Natural Ecosystems* (Washington D.C.: Island Press, 1997): 26.

[43] Gretchen Daily et al., *Nature's Services, Societal Dependence on Natural Ecosystems* (Washington D.C.: Island Press, 1997): 26.

[44] Robin Attfield, "Biocentrism," *The International Encyclopedia of Ethics* (2013): 526 & Gretchen Daily et al., *Nature's Services, Societal Dependence on Natural Ecosystems* (Washington D.C.: Island Press, 1997), 26 &28.

[45] Robin Attfield, "Biocentrism," *The International Encyclopedia of Ethics* (2013): 526 & Gretchen Daily et al., *Nature's Services, Societal Dependence on Natural Ecosystems* (Washington D.C.: Island Press, 1997), 28.

[46] Originally in Kant's own work this value was only imparted on human beings, but since then it has been extended to include sentient beings and plants (Robin Attfield, "Biocentrism," *The International Encyclopedia of Ethics* (2013): 527).

Intrinsic value is in opposition with 'instrumental' value; it is in opposition with the idea that phenomena have a value if they prove to be of utility to something else; in Kantian terms instrumental value can be characterised as a phenomenon being a means-to-an-end and not an end-in-itself, the latter of which would imply intrinsic value.[47]

In terms of ecosystems and a potential intrinsic value I foresee some problems however, and it revolves around the *action* of valuing. It is clear that human beings can value phenomena; humans appreciate, prefer, and judge with regards to things around them and themselves. In a way we can assume sentient beings value in a comparable way to humans, they too have sensational preferences, will gravitate towards pleasurable experiences and recoil from unpleasant experiences, and thus have an interest in their life.[48] It is not so clear however, that they 'judge' or 'appreciate' like we do. Even plants in a way share a capacity to prefer conditions over others. Studies have shown that some plants are sensitive to dangers in their environment, react to this danger by e.g. expelling chemicals to ward of insect attacks to survive and even communicating this danger to other individuals in their community.[49] This could all be rather mechanistic however, and I would not want to go so far as to say as that plants experience any of this in a way that you could call it valuing.

So the question then becomes: what do we mean with 'value' and particularly 'intrinsic value'? To me it seems that value is something that is ascribed to a phenomenon and this ascription implies a (mild) awareness and consciousness; value is ascribed by something in some form of awareness as distinct from just taking a phenomenon for granted or merely mechanistically reacting to circumstances. Therefore *intrinsic* value necessarily is a form of value that is ascribed by a phenomenon to *itself* as it is ascribed irrespective of external relationships; intrinsic value can only be granted by the consciousness of the thing to itself[50]. It is therefore questionable that plants and ecosystems can have intrinsic value, according to this conception, as they lack awareness[51]. Even for some animals who have not got a sense of self-awareness[52] this intrinsic value might be difficult to argue for.

Mine might be a narrow conception of valuing, as one could argue that beings can value ex- and implicitly, where implicitly would mean that a plant values its nutrition in the sense that it needs it. However, is that really what it means to value something in our common understanding of the word? This is not to say that plants or animals without self-awareness have *no* value, it is just to say that it makes no sense to speak of *intrinsic* value so we should look for another type of value such as an appreciation of (mildly) instrumental values. Maybe we should even consider dropping the concept of value altogether and look towards conceptions of *function* and *properties* that can explain the 'value' of a phenomenon in relation to its environment; a beech tree has distinct properties (e.g. a tough green-brown bark, leafs it loses in winter and beech nuts) and functions (e.g. survival of beeches as a species and cycling nutrients) that make it a beech rather than an oak, but it gains its value in relation to other beings in the environment be it other animals it provides shelter for or the admiration of human beings. The danger in this is of course that humankind fails to come up with the appreciation for say a beech tree, but this (to my mind) is not solved by arguing for a hardly

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[47] Robin Attfield, "Biocentrism," *The International Encyclopedia of Ethics* (2013): 527.
[48] See e.g. Peter Singer, *Practical Ethics* Cambridge: Cambridge University Press, 1979, 33-36.
[49] See e.g. Martin Heil & Richard Karban, "Explaining evolution of plant communication by airborne signals" *Trends in Ecology and Evolution* Vol 25, No 3 (2009): 137.
[50] Or by the acknowledgement of its divinity as a part of God's creation. This is an option I shall not further explore, because I want to discuss philosophical and not theological arguments.
[51] Not to mention that the concept of 'ecosystem integrity' that might follow from a deontological standpoint is controversial to say the least. Ecosystems are dynamic, ever changing systems and to determine their, quite static, integrity would be a mammoth task.
[52] Unlike elephants, dolphins and chimpanzees for example. See e.g. Christophe Boesch, "What Makes Us Human (Homo Sapiens), The Challenge of Cognitive Cross-Species Comparison," *Journal of Comparative Psychology* 121, no. 3 (2007): 233.

defendable intrinsic value of the beech tree which is very abstract and beyond the grasp of most people. It is rather solved by bringing it back to our (very human) cognitive ability to value and revising how we *properly* evaluate nature. I will propose how we might start this revision in part four of the paper.

Concluding CBA in conjunction with an ecosystem services framework are often enlisted in the governance of ecosystems. At the basis of this governance strategy are essentially utilitarian assumptions; we can know the costs and benefits of certain (in)actions with regards to ecosystems and their functions and with this knowledge can (monetarily) weigh our policy options. However, these assumptions fail to acknowledge that humans often lack the proper knowledge to evaluate ecosystem functions properly and neglect their potential value. Intrinsic value ascriptions are often proposed in philosophy as an alternative mode of evaluation, but these ascriptions I consider to be too abstract and sometimes even illogical. This leaves us to reconsider our methods of evaluation and governance of ecosystems and taking a precautionary approach and going back to a (mildly) instrumental and anthropocentric method might have to be up for negotiation. I will take this challenge up in the third and fourth part of this paper.

3. Precautionary principle as an alternative

If we consider the economic approach and non-anthropocentric philosophical approaches to be inadequate for dealing with the risk of LoER, we have to at least propose an alternative. The alternative will necessarily refrain from putting the burden of proof on precise predictions and quantitative or too abstract ascriptions of value. One such alternative which is proposed by people involved in policy making is abiding by the PP.

The concept of being precautionary is arguably something that is deeply rooted in common sense. It can be found in the very foundations of societies in sayings like "it is better to be safe than sorry". Various scholars ascribe the origin of the PP to be the German *Vorsorgeprinzip*.[53] Environmental scientists Tim O'Riordan and Andrew Jordan and barrister James Cameron argue that the PP is founded on this very same basis as it "is a culturally framed concept that is constructed from changing social judgements about the appropriate roles of science, economics, ethics, politics and law in anticipatory environmental protection and management"[54]. From this description we can take three core elements that the PP encompasses: 1) it concerns a *judgment*, 2) which is *socially constructed*, and 3) assigns *appropriate roles* to disciplines that are involved in anticipatory management[55]. In what way it is a social construct and whether it is capable of assigning roles to disciplines or does indeed do this is disputable, but accepting at least that the PP concerns judgments makes it clear that we are talking about a normative principle[56]; it is a principle that prescribes actions. For simplicity's sake I have chosen to present the following PP in this paper to give you as readers an idea of what it prescribes:

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[53] T. O'Riordan et al., 'The Precautionary Principle and Civic Science' in T. O'Riordan, J. Cameron, and A. Jordan (eds), *Reinterpreting the Precautionary Principle,* London: Cameron May Ltd. (2001)*:* 9 & N. De Sadeleer, *Environmental Principles: From Political Slogans to Legal Rules* (Oxford University Press 2005): 93.

[54] T. O'Riordan et al., 'The Precautionary Principle and Civic Science' in T. O'Riordan, J. Cameron, and A. Jordan (eds), *Reinterpreting the Precautionary Principle,* London: Cameron May Ltd. (2001)*:* 9.

[55] O'Riordan et al. discuss environmental protection and management exclusively. The reason I do not, is that the PP is also prevalent in anticipatory management of public health which is often distinguished from environmental management. The issues they address can however, overlap or the issues could even come down to the same underlying problems.

[56] In the philosophical sense, rather than the political sense where it might mean a principle that describes the norm in behaviour. See e.g. Stephen D. Krasner, *International regimes*. Cornell University Press, (1983): 158.

> When substantial evidence indicates that an activity threatens human health or the environment, take precautionary measures to prevent or reduce such harm, even if some of the cause-and-effect relationships are not well established, scientifically.[57]

This is just one of the many formulations and this variety of PPs makes it a seemingly incoherent principle. However, I would argue that all PPs at least include: 1) a statement about *harm avoidance* being the PPs (partial) objective, 2) a stance on the *level of knowledge* sufficient for making precautionary decisions, and 3) a view on what the PP should aim to *achieve in society*, be it sustainable development or highest benefits for the lowest possible costs.[58]

The way some scholars, like Daniel Steel and Cass Sunstein, claim the PP relates to other (quantitative) measures like risk analysis (RA) and CBA for dealing with risk, uncertainty and ignorance is especially telling of epistemological assumptions. In general it can be said that the PP is a guide in decision making even if there is no quantitative RA, to this most scholars would agree.[59] Where scholarly opinions on the role of the PP differ is its further relation to RA and CBA. On the one hand RA (and CBA) and the PP can be considered to be operative in two separate domains: RA occupies the domain of probability and the PP is excluded from this, occupying the domain of uncertainty[60].[61] This directly opposes another view in which RA is said to play a part in determining uncertainty and this is what links it to the PP: RA can be a quantified guide to making precautionary decisions.[62] However, RA and the PP are still distinct, even in the latter line of argument. Where RA gives a quantified description of possible risks, the PP is a prescriptive rule that dictates decision making.[63] In this sense CBA and the PP have more in common, both being a decision rule.[64] Underlying this stark divide between or the intertwinement of the PP and RA/CBA are assumptions as to what sort of knowledge we can expect to gather and how weighty this knowledge is; they are underpinned by epistemological assumptions. The view dividing PP and RA/CBA seems to assume that uncertainty can altogether be eliminated by ascribing a probability to the occurrence of an event, whereas the one intertwining PP and RA/CBA seems to assume that uncertainty is ever pervasive in predictions and probability ascriptions.

At first glance this divide seems to be a mere matter of definition as to what 'certainty' means. However, to accept that uncertainty is either reducible or pervasive has repercussions in our treatment of risks and in our use of the PP[65]. Additionally, the conception that uncertainty is

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[57] G.T. Miller, and S.E. Spoolman. *Living in the Environment.* 17th edition. Canada: BROOKS/COLE CENGAGE Learning, 2010, 624. I chose this formulation, because it seems to be relatively neutral in terms of possible interpretations, but still clear on when the PP should be enacted.

[58] These three elements I have extracted from a comparison between the PPs in: 1) United Nations Economic Commission for Europe (United Nations Economic Commission for Europe *(ECE), Ministerial Declaration on Sustainable Development in the ECE Region,* Bergen, May, 1990, para 7), 2) European Union (European Union http://ec.europa.eu/agriculture/glossary/index_en.htm#precautionary-principle last accessed 18-05-2016), and 3) the 1992 United Nations Framework Convention on Climate Change (UNFCCC http://unfccc.int/resource/docs/convkp/conveng.pdf last accessed 11-01-2016).

[59] Daniel Steel, *Philosophy and the Precautionary Principle: Science, Evidence, and Environmental Policy.* (Cambridge: Cambridge University Press, 2015): 111.

[60] Uncertainty being defined the inability to assign probabilities.

[61] See e.g. Cass Sunstein, *Laws of Fear: Beyond the Precautionary Principle,* (Cambridge: Cambridge University Press, 2005) & Frank H. Knight, *Risk, uncertainty and profit*. Courier Corporation, 2012: 233.

[62] See e.g. Daniel Steel, *Philosophy and the Precautionary Principle: Science, Evidence, and Environmental Policy.* (Cambridge: Cambridge University Press, 2015), R.A. Posner, *Catastrophe: Risk and Response,* (Oxford: Oxford University Press, 2004) & T. O'Riordan et al., 'The Precautionary Principle and Civic Science' in T. O'Riordan, J. Cameron, and A. Jordan (eds), *Reinterpreting the Precautionary Principle,* (London: Cameron May Ltd. 2001).

[63] Daniel Steel, *Philosophy and the Precautionary Principle: Science, Evidence, and Environmental Policy.* (Cambridge: Cambridge University Press, 2015): 111.

[64] Ibid.: 113.

[65] If we believe uncertainty is reducible the usefulness of the PP is equally diminishable, if we believe uncertainty is pervasive the PP is ever relevant.

reducible can ultimately lead to policymakers taking a hesitant stance on acting on preliminary results indicating a risk will develop in the future, whereas the conception that uncertainty is to an extent irreducible will most probably have us reflect on the level of knowledge needed to take action. Moreover, postponing taking action on issues to do with LoER specifically, but also CC in general, will most likely exacerbate the gravity of the risks and leave us with a limited time-frame to tackle them by.

Gambling with diminishing timeframes on impactful matters like these can be deemed highly irresponsible, even immoral. From a philosophical perspective the only defendable standpoint seems to be that uncertainty is pervasive, even in the most thorough RAs; it is most widely accepted by philosophers that methodologies used in empirical science cannot yield certainty, through induction we can never guarantee the future is coherent with past findings and through deduction we are making necessary assumptions (mostly based on induction).[66] The philosophical defence of following the PP on a bigger scope is therefore to be expected. In the context of LoER it is even more obviously a case for endorsing the PP, as the general perception is that the relevant science is highly uncertain. But then the question arises: how can it guide us in making the (morally) right decisions?

In conclusion the PP is often proposed as an alternative governance strategy to CBA and RA. It is a normative principle that states that action should be undertaken to avoid harm for the betterment of society even if there is only (highly) uncertain scientific knowledge available about a risk. Characteristically it guides policy-making in uncertain circumstances which could lead to accepting we have to take a precautionary stance in any policy decision if we grant that uncertainty is ever pervasive even in precise RAs and CBAs. In the case of LoER a precautionary approach is all the more justified, as scientific uncertainty is clearly pervasive in its science. How we should let the PP guide our (moral) decisions I will now come to in the fourth and last part of this paper.

4. Interpreting the precautionary principle

We have read that the science to assess LoER as a fat tail problem of CC is rather ambiguous; ecologists struggle to express the full extent of ecosystem degradation due to CC and the adversity of its consequences. An economic approach that rides on these predictions is bound to be faulty and therefore we might want to enlist the PP, because it is an alternative method for assessing our (policy) options and does not require precise prediction, but rather preliminary indications of causation. Now we have established this we have to turn our attention to interpreting the PP, which is no small task.

Ultimately choosing any policy option is a matter of ethics, since it involves making a value judgment about which adverse effects to counter and what good to endorse for the betterment of society. Therefore interpreting the PP is ultimately a matter of ethics too. As we have seen in part two of this paper utilitarianism is an ethical theory usually associated with the economic approach, and although it does have its merits I believe it is inadequate in tackling the ethical issues that arise in governance settings that aim to deal with LoER due to CC, for reasons I named before. Alternatively we could look towards Kantian and deontological approaches, giving accounts of the need for a respect for integrity and autonomy in nature in addition to sentient beings. However, as I have expressed in part two: this approach is rather abstract and I believe philosophically indefensible to an extent. So what other options are we left with?

[66] See for the problem of induction Hume, David. *A Treatise of Human Nature*. 3rd ed. Mineola, New York: Dover Publications, 2003: 54-56 & S. Okasha, *Philosophy of Science: A Very Short Introduction*. (Oxford: Oxford University Press, 2002): 24-8.

Virtue-ethics

An ethical approach that might sidestep these issues is virtue-ethics. Virtue-ethics regained territory on the playing field of ethics in the second half of the 20th century.[67] It is an ethical theory that defines what is morally right by reviewing what characteristics a person must obtain in order to become moral, not by sole reference to what yields the best results in terms of utility or by stating what duty you could want everyone to act on.[68,69] For *environmental* virtue-ethics the main question to answer is consequently agent-centred: which character traits should a person obtain to become ecologically virtuous?

Virtue-ethics finds its origin with the Greek philosopher Aristotle.[70] Virtues are character traits that every person should try to obtain to become moral and one can only obtain them through repetition, making them into habits.[71] It takes both willpower and perseverance to do this. To determine how to act virtuously there is one essential virtue in Aristotelian ethics that has to be obtained, namely *phronesis*. This concept can be translated with 'prudence' or 'practical wisdom' and is most important in determining which act is the most virtuous and thus a prerequisite for obtaining all other virtues.[72] Aristotle presses that the obtainment of prudence can only be done by acquiring contextual knowledge relevant to a great variety of situations and can only be gained through experience. This contextual knowledge consists of both theoretical and practical input and it is in essence as philosopher Rosalind Hursthouse describes *worldly knowledge*. This consists of knowledge of the workings and status quo of the world, of the method to cultivate virtues and the ability to reflect on and potentially change the course of your life.[73] This virtue can be recognised by people in others and these persons can be labelled as *phronimoi*, wise people that lead by example.[74,75]

To Aristotle the ultimate reason for trying to obtain an all-round virtuous character is to reach the goal of *eudaimonia*. This ancient Greek concept is often translated with 'happiness', but it would be more accurate to translate it with 'succeeding'.[76] It is important to note that Aristotle's virtue-ethics is a teleological theory, which means that everything in nature can be explained by reference to the goal or purpose (*telos* in ancient Greek) a process, cycle or organism has.[77] What it means to reach this goal for humans, but also beings in general, is to become a fully-fledged and flourishing member of its species. What it entails to flourish as a being is in line with using exactly

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[67] See e.g. MacIntyre, Alasdair *After Virtue* A&C Black, 2013. & R. Hull, "All About EVE: A Report on Environmental Virtue-ethics Today." *Ethics & the Environment.* 10, no. 1 (2005): 89-110.

[68] M. Zwolinski, en D. Schmidtz, "Environmental Virtue Ethics, What it is and what it needs to be," In *The Cambridge Companion to Virtue*, edited by D.C. Russell, (Cambridge: Cambridge University Press, 2013): 223-224.

[69] According to philosophers Matt Zwolinski and David Schmidtz the main reason why virtue-ethics is more helpful then other ethical theories is because it does not try to come up with universalisable moral rules, but rather with principles in the form of virtues to abide by. As a consequence virtue-ethics is able to stay sensitive to contextual differences that might change what the morally right course of action is. Utilitarianism and deontology both attempt to answer the question 'what makes an action correct and universalisable?' and herewith try to present one universal criterion for judging morality that people can follow, respectively maximalisation of pleasure and endorsing autonomy. The insensitivity to context and the lurking orthodoxy of people following these single criteria can have immoral implications.

[70] The reason for referring back to Aristotle rather than starting from the 20th century virtue-ethics is that I want to make use of some of the quintessentially Aristotelian concepts like prudence, flourishing and his teleological framework that have been diminished in importance or even lost in the more modern versions of virtue-ethics.

[71] Aristotle, "Ethica Nicomachea (Nicomachean Ethics)," In *Introduction to Aristotle,* 2nd ed. Edited by Richard McKeon, Chicago: The University of Chicago Press, 1973, 1095b3-6, 1103a25-b25 & 1180a15-19.

[72] Ibid.: 1107a1-2 & 1144b35-1145a5.

[73] Hursthouse, R. *On Virtue Ethics* Oxford: Oxford University Press, 1999. 307-308.

[74] Aristotle, "Ethica Nicomachea (Nicomachean Ethics)," In *Introduction to Aristotle,* 2nd ed. Edited by Richard McKeon, Chicago: The University of Chicago Press, 1973, 1140a25-28.

[75] In the past century these phronimoi would have been, among others, Nelson Mandela, Mahatma Ghandi and the Dalai Lama but also people closer to home, perhaps a teacher or church leader.

[76] Aristotle, "Ethica Nicomachea (Nicomachean Ethics)," In *Introduction to Aristotle,* 2nd ed. Edited by Richard McKeon, Chicago: The University of Chicago Press, 1973, 1097a15-1098a20.

[77] C. Witt, "Teleology in Aristotelian Metaphysics," In *Method in Ancient Philosophy*, 1st ed. Edited by J. Gentzler, Oxford: Oxford University Press, 1998, 253.

those faculties that are essential to the nature of that being. The faculty that is characteristically (some argue uniquely) human and discerns what is morally correct is rationality; making rational choices is paramount to becoming a successful human being.[78] However Aristotle also acknowledges that emotions are essential to a moral human life, because they make us aware of what we approve of and what we are repulsed by and subsequently can make us strive for what we feel is morally right and avert what is morally wrong. Acknowledging that we are both rational and emotional animals can be described as a form of necessary self-understanding and we need to balance these two sides in order to make virtuous choices. Yet these emotions can be off the mark in that they give an inaccurate representation of what value something holds regarding the goal we strive for. It is therefore important that a person who wants to be prudent and virtuous always weighs her rational considerations and emotions and corrects the latter where needed.[79, 80]

A general objection made against virtue-ethics is that it is rather subjective. This objection seems valid if you look at the way in which morality is determined. Although morality is based on common human nature, the guarantee that deliberation processes will always end with a moral choice seems rather doubtful, making universalisable rules from utilitarianism and deontology more appealing because of their rigidity. However, Aristotle pressed the importance of the public sphere for morality too.[81] He described human beings as a social animal (*zōon politikon*), an animal that needs the community in order to live a flourishing life.[82] The idea of commonly held virtues that are backed up by good law enforcement from politics was essential to keeping up his whole ethical system.[83] Justice is illustrative of the link Aristotle acknowledges between ethics and politics and was defined as the virtue that helps work towards the common benefit of people or 'common advantage'.[84] So morality may not be as 'objective' as it is in utilitarianism and deontology, but it is based on commonly held principles and to the benefit of a community, so it is an approximation of universalisation. Also, to my mind it is worth more that people are reflective in their decision making and train their reflexivity on the different values they hold, rather than follow a moral law or single criterion blindly.

Contemporary virtue-ethicists have adapted virtue-ethics to become suitable for the environmental ethics debate, starting the movement 'environmental virtue-ethics' (EVE). The different EVE philosophers have various approaches to presenting their theory of how humans should relate to nature. These can be summarised in three categories, namely by a focus on: 1) role-models[85], 2) a list of specific eco-virtues or criteria[86] and 3) human flourishing[87]. These approaches hark immediately back to the essential aspects of Aristotelian ethics just presented; phronimoi, virtues and eudaimonia. There are a few trends discoverable in the EVE theories. For example the

[78] Aristotle, "Ethica Nicomachea (Nicomachean Ethics)," In *Introduction to Aristotle,* 2nd ed. Edited by Richard McKeon, Chicago: The University of Chicago Press, 1973, 1094a1-1097a14, 1098a21-1098b8 & 1177a12-1178b32.
[79] Ibid. 1139a21-31.
[80] This equation of what is good (flourishing) with what is natural (a balance of rationality and emotion) seems to have fallen prey to the naturalistic fallacy and the is-ought problem. Unfortunately I have not got the scope to explore this valid objection. I would just like to say that this objection does not necessarily hold up if moral agents reflect properly.
[81] Aristotle, "Ethica Nicomachea (Nicomachean Ethics)," In *Introduction to Aristotle,* 2nd ed. Edited by Richard McKeon, Chicago: The University of Chicago Press, 1973, 1094b4-7.
[82] Aristotle, "Politica (Politics)," In *Introduction to Aristotle*, 2nd ed. Edited by Richard McKeon, Chicago: The University of Chicago Press, 1973, 1252b29–30 and 1253a31–37
[83] Aristotle, "Ethica Nicomachea (Nicomachean Ethics)," In *Introduction to Aristotle,* 2nd ed. Edited by Richard McKeon, Chicago: The University of Chicago Press, 1973, 1094a1-b12 & 1179a33-1181b25.
[84] Aristotle, "Politica (Politics)," In *Introduction to Aristotle*, 2nd ed. Edited by Richard McKeon, Chicago: The University of Chicago Press, 1973, 1160a10-14.
[85] See e.g. P. Cafaro, "Thoreau, Leopold, and Carson: Toward an Environmental Virtue Ethics," *Environmental Ethics*, 22, no.1 (2001): 3-17.
[86] See e.g. Thomas E. Hill Jr., "Ideals of Human Excellence and Preserving Natural Environments," *Environmental Ethics*, 5, no. 3 (1983): 211-224.
[87] See e.g. L. van Wensveen, "Ecosystem Sustainabiliy as a Criterion for Genuine Virtue," *Environmental Ethics*, 23, no. 3 (2001): 227-241.

eco-virtue 'humility'[88] is often presented as important, and non-anthropocentric and - materialistic views are often endorsed.[89] Especially interesting is the non-anthropocentric tone in many of the EVE discourses, a tone that to my ears departs from Aristotle's views. For Aristotle morality and what we value is deeply entangled with our human nature. And, as we have read, I hold that awarding intrinsic value apart from (semi-)conscious minds is unfounded. That is why I will not subscribe to a non-anthropocentric virtue-ethics myself.

An anthropocentric EVE could argue that what non-conscious nature in itself holds, has nothing to do with 'value'. Whatever 'value' nature has, may have more to do with the 'function' particular elements have that make the whole work. This view can be seen as a distillation of Aristotelian ethics, from which respect for the telos - the purpose of a phenomenon - of natural systems can be emphasised.[90] The problem with this view however, is that not everything in nature that has come about through evolution has an actual purpose or not one we can fathom as of yet. This problem can be circumvented by acknowledging that overall the purpose of nature is to adapt and evolve to survive. There is a reason why things evolved the way they have as that state of being might been optimal considering the circumstances. I think it would be the strong point of EVE if it argues that the natural states of phenomena should be respected out of prudence for what might befall us and other parts of nature if we deregulate the natural order[91]; the PP could prescribe us to be prudential in our dealings with the natural order of things. Just like you should not bring the (arguably) similarly evolved social, but also rational and emotional nature of humans in misbalance. So should we not unnecessarily deregulate the nature of phenomena around us. I will come back to this evolutionary ethic in the next part.

Evolutionary biology

The way we describe the world to be and the way in which we believe we ought to behave might be more intertwined than some think[92]. What humans feel is the morally right thing to do can arguably be explained from the discipline of evolutionary biology as a natural and evolutionarily instilled inclination to promote whatever is the most optimal solution to problems humanity encounters, even if we do not realise or comprehend it rationally. Therefore in evolutionary biology there is both a place for an emotional and a cognitive defence of the moral values we hold. The ethical theory of philosopher David Hume is often endorsed and praised in evolutionary biology for its complementing nature. I will add Aristotle's virtue-ethics to this and elaborate on how I think both Humean and Aristotelean ethics are in line with evolutionary biology and helpful in our dealings with nature. In order to do this I will first analyse the theories of philosopher and ecologist Ricardo Rozzi, evolutionary anthropologist Oliver Scott Curry and primatologist Frans de Waal.

Rozzi states that the domains of nature and culture have reciprocal influences and attempt to demonstrate this by referring to Charles Darwin's work[93] in which we find explanations of both social and selfish behaviour in human beings. On the one hand Darwin presents how people understand

[88] C. Frakes, and M. Pianalto, "Part III, Environmental Virtue," In *Virtues in Action,* 1st ed. Edited by Michael W. Austin, New York: Palgrave Macmillan, 2013: 118-149.
[89] See for example by Cafaro and Hill in: R. Hull, "All About EVE: A Report on Environmental Virtue Ethics Today" *Ethics &the Environment*. Vol 10, no 1, (2005): 93-96.
[90] R. Hull, "All About EVE: A Report on Environmental Virtue Ethics Today" *Ethics &the Environment*. Vol 10, no 1, (2005): 91.
[91] 'Natural order' is a dynamic concept, so living with it, and more specifically without upsetting it, is itself a great challenge. Essentially humans have to learn to live with nature's dynamics, requiring great flexibility and adaptive capacity on our part.
[92] The fact-value distinction, is-ought problem and naturalistic fallacy still hold philosophers prisoner to this day. They are all valid issues I cannot address here unfortunately.
[93] See Charles Darwin *On the Origin of Species by Means of Natural Selection.* 1st ed. London: Murray. Reprint, Cambridge (MA): Harvard University Press, 1964: 5 & 129–130.

that organisms are closely related to one another and consequently feel an affiliation with other living species.[94] This to Rozzi explains our social predisposition towards our environment, our sense of community as the cradle of morality. On the other hand Darwin describes individualistic and selfish behaviour for survival at the expense of others.[95] This can explain our selfish predispositions, our sense of the self and self-preservation.

However this does not yet show how these two sides to natural organisms interact. Recent studies by De Waal have indicated that primates (and possibly other animals), among which us the *homo sapiens*, are naturally inclined to act socially and sometimes even altruistically over egoistically. Altruism here, is an act that is to the benefit of another at the expense of oneself.[96] Empathy, defined in biology as the ability to assess the reason for the emotional state of another, adopting their perspective (cognitive empathy) and to be affected by and share that state (emotional contagion), is presented as the driving force behind this social behaviour.[97] In the light of evolution the function of social and empathetic behaviour is now said to boil down to the fact that cooperation and behavioural copying are a means of survival.[98] By copying another's behaviour the behaviour of a group can be adapted that might entail that the group as a whole is more suited to the environment and thus able to survive.[99] It can be argued that our moral systems have arisen from the same background of empathetic sentiments and an evolutionary need for cooperation.[100, 101] Furthermore in groups of non-human primates it is shown that they actively try to re-establish harmony after discordance by e.g. reconciliation or protesting about inequality.[102]

This 'normativity' in non-human primate behaviour may well be indications that our normative systems, rooting for amongst other things justice and condemning violence, has an evolutionary origin.[103,104] Studies suggest that during the upbringing of both non-human and human primates we need to gain experience-based knowledge of our physical surroundings in order to develop a cognitive ability of assessing these surroundings and know how to interact with them effectively, this is called 'ecological imprint'.[105] That our biological make-up and our direct environment[106] together provide ingredients for our (moral) behaviour seems rather deterministic. However humans have an enormous variability of environments in which they can move around freely and increasingly so due to globalisation, adding to their experience and consequently to their diversity of cognitive abilities, character and culture.[107, 108]

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[94] Ricardo Rozzi, "The Reciprocal Links between Evolutionary–Ecological Sciences and Environmental Ethics," *BioScience* 49, no. 11 (1999): 911 & 915-917.
[95] Ibid. 915-916.
[96] Frans B.M. de Waal, "Putting the Altruism Back into Altruism: The Evolution of Empathy," *The Annual Review of Psychology,* 59 (2008): 289.
[97] Ibid.: 281-283.
[98] Ibid.: 288.
[99] Ibid.
[100] Jessica C. Flack and Frans B.M. de Waal, "'Any Animal Whatever' Darwinian Building Blocks of Morality in Monkeys and Apes," *Journal of Consciousness Studies* 7, no. 1-2 (2000): 1.
[101] Frans B.M. de Waal, *Good Natured: The Origins of Right and Wrong in Primates and OtherAnimals* (Cambridge, MA: Harvard University Press, 1996). 31.
[102] Frans B.M. de Waal, "Natural Normativity: The 'is' and 'ought' of Animal Behavior," *Behaviour* 151 (2014): 185.
[103] Ibid.
[104] Furthermore, our culture may be said to result from moral tendencies in our nature. However, the specifics of how certain trends come about can still come down to non-predetermined factors. Multiple studies back up this view by illustrating the importance of mostly contingent, environmental aspects on the behaviour of humans and not just our inherent, genetic tendencies. See e.g. Robert L. Trivers, "The Evolution of Reciprocal Altruism," *The Quarterly Review of Biology* 46, no. 1 (1971): 53.
[105] Christophe Boesch, "What Makes Us Human (Homo Sapiens), The Challenge of Cognitive Cross-Species Comparison," *Journal of Comparative Psychology* 121, no. 3 (2007): 227 & 235-236.
[106] With 'environment' experts mean not only our physical, but also our social surroundings.
[107] Ibid.: 236.
[108] Moreover, science, as a part of our culture, can shape the way we see the world around us. The system of science arguably follows the process of biological evolution; the cultural trends, namely theories, comprising science are arguably selected on their most accurate

To Curry it is clear that Humean philosophy[109] and especially Humean ethics merges quite naturally with the views of evolutionary biology.[110] He stresses Hume believed that human nature provides us with certain passions that are shared by most of humanity and hence give rise to common, moral values or, as Hume called them, virtues.[111] By analysing Darwin's and De Waal's observations we could see that Hume 'was right': it turns out that human psychology is comprised partly of 'adaptations for cooperation', meaning that mankind is naturally inclined to behave socially as a means of living a peaceful life and surviving.[112] That is not to say that humans naturally behave morally, because, as we all know, we also have what we consider to be 'immoral' inclinations (e.g. having aggressive, free-riding or even murderous tendencies). In part it is therefore up to the reflective mind of humans to decide right from wrong. Humean ethics seems to resonate Aristotelian virtue-ethics in that they both use the concept 'virtue' to specify what is morally right and acknowledge that living up to the virtues includes the correct weighing of the social/emotional and rational facets of human psychology. What I believe Humean theories lack that Aristotelean theories can make up for is in specifying the method of how to become a moral person; the virtue *phronesis* is key to the method of becoming a virtues person.

<u>Combining the two</u>

The similarities between virtue-ethics and evolutionary biology are, to me, very interesting: 1) both acknowledge that improving behaviour can be done by going out into the world and learning through experience, trial and error, 2) knowing what is right is subject to both cognition and emotional response and last, but not least, 3) both see an important role reserved for the copying of another's behaviour that will ultimately benefit the self and community. The only difference between natural improvement and human moral improvement is that humans can reflect on and direct their (prospective) actions and character traits and be more selective in what they pursue and what not where nature cannot.

The fact that ecology and this specific ethical theory are, to an extent, in line illustrates to me how effective it can be to combine the two in assessing how we should live within the natural world. I believe that by promoting an ethical theory that is rooted in human nature but also in nature more broadly, ethicists can come up with a method of getting more and more people involved in pursuing what is considered environmentally moral. By acknowledging that evolution underpins almost all systems in the world, natural or cultural, we may awaken a form of respect or even empathy in humanity that will promote the conservation of natural systems as the morally right thing to do. Evolution tells us that everything has a history that has caused things to develop as intricately as they have and to disrupt this unexplored, historical intricacy, trying to replace it by new systems that are less adapted may be very unwise and incautious. Therefore I would advise to adopt an environmental-virtue-ethic that has regard for this evolutionary history and will promote humanity to become ecologically virtuous for the sake of themselves and the communities they are part of.

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formulation of reality. As philosopher Karl Popper stated, scientific theories come about through *trial and error*, attempts to try to find a fitting solution (theory) to a problem (gap in our understanding), just like natural evolutionary processes, only in science the process of selecting the most accurate and adapted theory is subject to conscious selection and in biology adaptations are not consciously made. So in this sense ecology as a science tries to come up with the most fitting theory for how natural systems work through its own trial and error. See e.g. Chris Buskes, *Evolutionair Denken, De invloed van Darwin op ons wereldbeeld* (4th ed. Amsterdam: Uitgeverij Niewezijds, 2008), 259-261.

[109] That is to denote 'philosophy as presented by Hume' and not the Humean tradition that came thereafter.

[110] Oliver Scott Curry, *Morality as Natural History, An Adaptationist Account of Ethics* (London: London School of Economics and Political Science, 2004), 2.

[111] Ibid.: 171.

[112] Ibid. 192-193.

This can then inform our interpretation of the PP: the combination of virtue-ethics and evolutionary biology will ensure that we attempt to make a precautionary attitude into a habit, by taking measures to maintain the workings of evolved systems and demand a respect for their intricacies, stemming from co-evolved interactions between organisms (be it human or non-human) and their environment.

Virtues I think we are mostly in need of in today's culture are *humility* and *courage*. We need to acquire a humble attitude with respect to the limits of our knowledge and the acknowledgement of human dependence on natural systems. The PP can potentially prescribe just that to policy makers in that we need to give due consideration to preliminary science, that has long been ignored in CC governance. We need to acquire a courageous attitude in speaking out about and taking action on early warnings of prospective harm and instigating the systemic change that is needed to adequately address the threats posed to us by CC and its aftermath.

Conclusion

Loss of ecosystem resilience due to climate change is one of the fat-tail problems that is overshadowed in governance by other, in policymakers' eyes more pressing risks. However, it will have serious repercussions in natural systems and in society and is therefore worth policymakers' precautionary attention.

The common way to go about protecting ecosystems in governance has been to specify ecosystem goods and services to be protected, put a monetary value on them and weigh human interest in these goods and services against the expenses and efforts of protecting them in a cost-benefit analysis. The assumption underlying this, what I called, 'economic approach' is that precise values can be given and accurate predictions can be made of the impact of (in)action and the functioning of ecosystems. However, ecology is a very complex study that leaves many uncertainties; uncertainties the economic approach might not be equipped to deal with.

The precautionary principle is often proposed as an alternative policymaking tool that can address this uncertainty. It arguably does not put the burden of proof on precise predictions and quantitative ascriptions of value, but teaches us to take preliminary scientific results seriously and be more proactive in our governance since scientific certainty can never be obtained.

The interpretations and formulations of the precautionary principle are however manifold. Therefore we have to enlist further criteria to interpret the principle by. In this paper virtue-ethics, with a particular emphasis on the virtues *humility* and *courage,* and evolutionary biology are put forward as theories that yield insights that can prove helpful in interpreting the principle for the purpose of addressing loss of ecosystem resilience. Both virtue-ethics and evolutionary biology describe how natural and social systems are underpinned by intricate interactions between organisms and their environment. Some of these organisms, like humans, have a capacity for emotional, social and rational tendencies and self-awareness. Balancing these capacities with the limitations of the physical environment will ultimately determine how these organisms flourish. A respect for these intricate relationships and complexities and a drive to obtain a precautionary attitude with regards to our dealings with these relationships is therefore paramount in safeguarding the wellbeing of human (or indeed any sort of) beings. And for the sake of harm avoidance this respect for evolution is of great importance in interpreting the precautionary principle.

References

Aristotle. “Ethica Nicomachea (Nicomachean Ethics).” In *Introduction to Aristotle,* 2nd ed. Edited by McKeon, Richard. Chicago: The University of Chicago Press (1973): 331-581.

Aristotle. “Politica (Politics).” In *Introduction to Aristotle*, 2nd ed. Edited by McKeon, Richard. Chicago: The University of Chicago Press (1973): 584-659.

Attfield, Robin. “Biocentrism.” *The International Encyclopedia of Ethics* (2013): 526 & Gretchen Daily et al., *Nature’s Services, Societal Dependence on Natural Ecosystems* Washington D.C.: Island Press (1997): 526-535.

Aven, T. and Renn, O. ‘An Evaluation of the Treatment of Risk and Uncertainties in the IPCC Reports on Climate Change.’ *Risk Analysis,* vol. 35, no. 4, 2015: pp.701-712.

Bartkowski, Bartosz, Lienhoop, Nele, & Hansjürgens, Bernd. “Capturing the complexity of biodiversity: A critical review of economic valuation studies of biological diversity.” *Ecological Economics* 113 (2015): 1-14.

Boesch, Christophe. “What Makes Us Human (Homo Sapiens), The Challenge of Cognitive Cross-Species Comparison.” *Journal of Comparative Psychology* vol. 121, no. 3 (2007): 227-240.

Buskes, Chris. *Evolutionair Denken, De invloed van Darwin op ons wereldbeeld* 4th ed. Amsterdam: Uitgeverij Niewezijds (2008): 259-261.

Cafaro, P. “Thoreau, Leopold, and Carson: Toward an Environmental Virtue Ethics.” *Environmental Ethics*, vol. 22, no.1 (2001): 3-17.

Curry, Oliver Scott. *Morality as Natural History, An adaptationist account of ethics* London: London School of Economics and Political Science (2004).

Daily, Gretchen et al. *Nature’s Services, Societal Dependence on Natural Ecosystems* Washington D.C.: Island Press (1997).

Daily, Gretchen and Dasgupta, Shamik. “Ecosystem Services, Concept of.” *Encyclopedia of Biodiversity* no. 2 (2001): 353-362.

Darwin, Charles *On the Origin of Species by Means of Natural Selection.* 1st ed. London: Murray. Reprint, Cambridge (MA): Harvard University Press (1964).

European Union http://ec.europa.eu/agriculture/glossary/index_en.htm#precautionary-principle last accessed 18-05-2016.

Flack, Jessica C. and De Waal, Frans B.M. “’Any Animal Whatever’ Darwinian Building Blocks of Morality in Monkeys and Apes.” *Journal of Consciousness Studies* 7, no. 1-2 (2000): 1-29.

Frakes, C. and Pianalto, M. “Part III, Environmental Virtue.” In *Virtues in Action,* 1st ed. Edited by Austin, Michael W. 118-149. New York: Palgrave Macmillan (2013).

Hale, Benjamin. "The world that would have been: Moral hazard arguments against geoengineering." *Reflecting sunlight: The ethics of solar radiation management. Rowman and Littlefield, Lanham* (2012).

Heil, Martin & Karban, Richard. “Explaining evolution of plant communication by airborne signals” *Trends in Ecology and Evolution* vol. 25, no. 3 (2009): 137-144.

Hill, Thomas E. Jr. “Ideals of Human Excellence and Preserving Natural Environments,” *Environmental Ethics*, 5, no. 3 (1983): 211-224.

Hughes, T.P. et al. “Climate Change, Human Impacts, and the Resilience of Coral Reefs “ *Science* 301, 929 (2008): 929-933.

Hull, R. “All About EVE: A Report on Environmental Virtue-ethics Today.” *Ethics & the Environment* vol. 10, no. 1 (2005): 89-110.

Hume, David. *A Treatise of Human Nature*. 3rd ed. Mineola, New York: Dover Publications (2003).

Hursthouse, R. *On Virtue-ethics* Oxford: Oxford University Press (1999).

Knight, Frank H. *Risk, uncertainty and profit* Courier Corporation (2012).

Krasner, Stephen D. *International regimes* Cornell University Press (1983).

Lei Dai et al. ”Generic Indicators for Loss of Resilience Before a Tipping Point Leading to Population Collapse.” *Science* 336 (2012): 1175-1177.

Lenton, T. “Early warning of climate tipping points.” *Nature Climate Change* (2011): 201-209.

MacIntyre, Alasdair. *After Virtue* A&C Black (2013).

Mawdsley, J. “Design of conservation strategies for climate adaptation” *WIRES Climate Change* vol .2, July/August (2011): 498-515.

Mill, John Stuart. *Utilitarianism* London: Parker, Son, and Bourn, West Strand (1863).

Miller, Fiona et al. “Resilience and Vulnerability: Complementary or Conflicting Concepts?” *Ecology and Society* vol.15, no.3, art.11 (2010): 1-25.

Miller, G. Tyler and Spoolman, Scott E. *Living in the Environment* Canada: BROOKS/COLE CENGAGE Learning (2010).

Mooney, H. et al. “Biodiversity, climate change, and ecosystem services.” *Current Opinion in Environmental Sustainability* 1 (2009): 46–54.

Norton, Bryan. “Anthropocentrism.” *The International Encyclopedia of Ethics.* (2013): 309-320.

Odum, Eugene P. “Ecosystem, Concept of.” *Encyclopedia of Biodiversity* 2 (2001): 305-310.

Okasha, S. *Philosophy of Science: A Very Short Introduction* Oxford: Oxford University Press (2002).

O’Riordan, T. “The Precautionary Principle and Civic Science” in T. O’Riordan, J. Cameron, and A. Jordan (eds), *Reinterpreting the Precautionary Principle* London: Cameron May Ltd. (2001).

Pimm, S.L. “Biodiversity: Climate Change or Habitat Loss — Which Will Kill More Species?” *Current Biology* vol.18, no.3 (2007): R117-9.

Posner, R.A. *Catastrophe: Risk and Response* Oxford: Oxford University Press (2004).

Rozzi, Ricardo. “The Reciprocal Links between Evolutionary–Ecological Sciences and Environmental Ethics.” *BioScience* vol.49, no.11 (1999): 911-921.

Singer, Peter. *Practical Ethics* Cambridge: Cambridge University Press (1979).

Steel, D. *Philosophy and the Precautionary Principle: Science, Evidence, and Environmental Policy.* Cambridge: Cambridge University Press (2015).

Sunstein, C., *Laws of Fear: Beyond the Precautionary Principle,* Cambridge: Cambridge University Press (2005).

Trivers, Robert L. “The Evolution of Reciprocal Altruism.” *The Quarterly Review of Biology* vol.46, no.1 (1971): 35-57.

United Nations Economic Commission for Europe. *Ministerial Declaration on Sustainable Development in the ECE Region,* Bergen, May, 1990, para 7.

United Nations Environment Program. http://web.unep.org/ecosystems/what-we-do/economics-ecosystems last accessed 07-09-2016.

United Nations Framework Convention Climate Change. http://unfccc.int/resource/docs/convkp/conveng.pdf last accessed 11-01-2016.

de Waal, Frans B.M. *Good Natured: The Origins of Right and Wrong in Primates and Other Animals* Cambridge, Massachusetts: Harvard University Press (1996).

de Waal, Frans B. M. “Natural normativity: The ‘is’ and ‘ought’ of animal behavior.” *Behaviour* 151 (2014): 185-204.

de Waal, Frans B.M. “Putting the Altruism Back into Altruism: The Evolution of Empathy.” *The Annual Review of Psychology* 59 (2008): 279-300.

van Wensveen, L. “Ecosystem Sustainabiliy as a Criterion for Genuine Virtue.” *Environmental Ethics*, 23, no. 3 (2001): 227-241.

Witt, C. “Teleology in Aristotelian Metaphysics.” In *Method in Ancient Philosophy*, 1st ed. Edited by Gentzler, J. Oxford: Oxford University Press (1998): 253-269.

Zwolinski, M. en Schmidtz, D. “Environmental Virtue-ethics, What it is and what it needs to be.” In *The Cambridge Companion to Virtue*, edited by Russell, D.C. Cambridge: Cambridge University Press (2013): 221-239.